Zweitakt-Brennkraftmaschine mit umlaufenden Zylindern

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Zusatz zum Patent 831 034
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Die vorliegende Erfindung bezieht sich auf eine vorzugsweise gemischverdichtende Zweitakt-Brennkraftmaschine, deren Arbeitskolben sich tangential zu der im allgemeinen senkrecht stehenden Welle hin und her bewegen und gleichzeitig zusammen mit ihren in einem gemeinsamen, etwa sternförmigen Körper angeordneten Zylindern konzentrisch zur Welle umlaufen. Das Drehmoment für die Umlaufbewegung des Zylinderkörpers und der Welle wird dadurch erzeugt, daß die Kolben sich nach außen gegen einen feststehenden Laufring mit einer dem Kolbenhub entsprechenden Exzentrizität gegenüber der Welle abstützen, und zwar im Sinn des Patentes 831 034 über je ein Fahrwerk mit zwei in den symmetrisch zur Kolbenachse angeordneten beiden Spuren des Laufringes geführten Rollen und einem Gestänge, das einerseits am äußeren Ende der Pleuelstange, anderseits am nachfolgenden Arm des Zylinderkörpers angelenkt ist. Das aus einem Querbügel und zwei seitlichen, die Lagerzapfen für die Rollen tragenden Streben bestehende Fahrwerkgestänge ist so ausgebildet, daß die Pleuelstange während des Kolbenhubes nur eine verhältnismäßig geringe Hinundherbewegung in der Umlaufebene ausführt, wodurch auch nur mäßige seitliche Kolbendrücke gegen die Zylinderwände auftreten und ein größeres Verhältnis von Kolbenhub zu Zylinderdurchmesser als bei einem üblichen Kurbeltriebwerk möglich ist.

Um nun die Leistungsfähigkeit einer solchen Brennkraftmaschine, bezogen auf das Hubvolumen, noch weiter zu steigern, wird die betreffende Bauart

gemäß dem Patent 831034 durch diese Erfindung weiterentwickelt. Die in diesem Sinn wesentlichsten Merkmale sind die Anordnung der für eine Axialspülung mit Einlaßventilen und Auslaßschlitzen versehenen Zylinder in möglichst großem Abstand von der Welle am äußeren Ende je eines Armes des Zylinderkörpers und die Verbindung der Zylinderauslaßschlitze am äußeren Hubende der Arbeitskolben mit in tangentialer Richtung ausmündenden Expansionskanälen, deren Seitenwände durch annähernd in Strömungsrichtung verlaufende kurze Rohrstutzen unterbrochen sind.

Im Zusammenhang damit sind noch weitere Änderungen und Verbesserungen vorgesehen, die sich teils aus der zweckmäßigen Einbaulage des Motors etwa in einem Fahrzeug ergeben, teils auch für eine vorteilhafte Betriebsweise desselben oder gute Zugänglichkeit einzelner Bauteile, wie z. B. der Einlaßventile, von erheblicher Bedeutung sind und im einzelnen nachstehend erläutert werden.

Der Gegenstand der Erfindung ist in der Zeichnung übereinstimmend mit dem Patent 831034 in der Ausführungsform einer dreizylindrigen Brennkraftmaschine dargestellt, wobei auch für die dort und hier einander entsprechenden Bauteile die gleichen Bezugszeichen verwendet werden; es zeigt

Fig. 1 die ganze Maschine in einer Ebene quer zur Welle, teils in Ansicht, teils im Schnitt,

Fig. 2 die Maschine im Axialschnitt,

Fig. 3 einen Arbeitskolben im Längsschnitt mit den auf einer Seite desselben liegenden Teilen seines Fahrwerkes,

Fig. 4, 5 und 6 je einen einzelnen Bauteil im Längs- bzw. Querschnitt sowie

Fig. 7 eine graphische Darstellung des seitlichen Ausschlages der Pleuelstange während des Kolbenhubes.

Auf der Welle 1 ist, nur zusammen mit dieser drehbar, ein dreiarmiger Körper 2 angeordnet, der am äußeren Ende seiner Arme 2^a, 2^b, 2^c, teilweise aus diesen herausragend, je einen Arbeitszylinder 3^a, 3^b, 3^c enthält. Mit dem inneren Ende jedes Zylinders, deren Längsachsen den größtmöglichen Abstand von den parallel zu ihnen verlaufenden Wellentangenten haben, steht ein Einlaßkanal 4^a, 4^b, 4^c in Verbindung. Diese radial zur Welle gerichteten Kanäle sind an ihrem äußeren Ende durch Gewindestutzen 18 verschlossen, in denen Zündkerzen 19 angeordnet sind. Im anderen Teil der Kanäle befinden sich Einlaßventile 20, deren bis in einen Ringraum 21 innerhalb der Nabenbohrung des Zylinderkörpers hineinreichende Stößel 22 mittels eines gemeinsamen, feststehenden Nockens 23 betätigt werden.

Die Arbeitskolben 5 haben eine als Rohr ausgebildete Pleuelstange 7, die einerseits mit dem Kolben, anderseits mit einem Abstützquerbügel 9 des Fahrwerkes durch eine kugelförmig gestaltete Lagerung 8^a bzw. 8^b gelenkig verbunden ist. An dem Querbügel sind symmetrisch zu beiden Seiten der Kolbenachse und parallel zueinander zwei unter sich gleiche winkelförmige Streben 10^a, 10^b mit verschieden langen Schenkeln befestigt, welche die Lagerzapfen 11^a, 11^b für je eine Laufrolle 12^a, 12^b tragen und am anderen Ende ihres längeren Schenkels mittels eines gemeinsamen Zapfens 13^a bzw. 13^b bzw. 13^c an einem vorspringenden Lagerbock 24 des in der Umlaufrichtung (vgl. den Pfeil I in Fig. 1) nachfolgenden Armes des Zylinderkörpers 2 angelenkt sind.

Dadurch ergibt sich ein viel kleinerer seitlicher Ausschlag der Pleuelstange als bei einem Kurbeltrieb für den gleichen Kolbenhub, weil die Drehachse der Laufrollen im Gegensatz zu derjenigen einer Kurbelwelle ihre Lage zur Kolbenachse verändern kann. Das äußere Ende der Pleuelstange bewegt sich also, wie in Fig. 7 veranschaulicht ist, auf einem Kreisbogen, dessen Radius der längere Schenkel der Streben 10^a, 10^b ist, die im Bereich eines Winkels α um die Gelenkzapfen 13^a bzw. 13^b bzw. 13^c hin und her schwenken. Die Sehne des Kreisbogens entspricht dem Kolbenhub H, während die von der Länge der betreffenden Strebenschenkel abhängige Höhe des Kreisbogens über der Sehne die ganze Seitenbewegung des äußeren Pleuelstangenendes darstellt. Um die Hälfte dieser Bogenhöhe wird demnach die Pleuelstange nach jeder Seite aus der durch die Linie K-A gekennzeichneten Kolbenachse ausgelenkt. Somit treten auch nur sehr geringe radiale Kolbendrücke gegen die Zylinderwand auf, was ein größeres Hub : Durchmesser-Verhältnis ermöglicht als bei Maschinen mit einem Kurbeltrieb.

Die beiden Laufrollen der einzelnen Kolbenfahrwerke sind in je einer im Querschnitt U-förmigen Rille 15^a, 15^b eines die Welle und den Zylinderkörper exzentrisch umgebenden, feststehenden doppelten Laufringes geführt, dessen gleichbleibende Spurweite durch ringförmige Abstandsbleche 25 gesichert ist (vgl. Fig. 2 und 6). Falls es erwünscht ist, den durch die Exzentrizität des Laufringes bedingten Kolbenhub verändern zu können, läßt sich das durch eine entsprechende (nicht gezeichnete) Verstelleinrichtung für den Laufring erreichen. In Fig. 1 sind die Stellen, an denen die Arbeitskolben beim Umlauf des Zylinderkörpers ihre innere und äußere Totpunktlage haben, mit *i. T.* bzw. *ä. T.* bezeichnet.

Eine Besonderheit der neuen Bauart stellen die Führung und Beeinflussung der aus den Arbeitszylindern durch am äußeren Hubende der Kolben angeordnete und von diesen gesteuerte Auslaßschlitze 26 austretenden Verbrennungsgase dar. Um den durch den Auspuffstoß entstehenden Rückdruck im Sinn der Leistungssteigerung der Brennkraftmaschine für das auf den Zylinderkörper und damit auch auf die Welle ausgeübte Drehmoment möglichst weitgehend nutzbar zu machen, werden alle Auslaßschlitze jedes Zylinders mit je einem sich entgegen der Drehrichtung des Zylinderkörpers erstreckenden Expansionskanal 27 verbunden, der so gekrümmt ist, daß die Abgase in seinem Austrittsquerschnitt eine in dem betreffenden Sinn tangentiale Strömungsrichtung haben, wie durch die kleinen Pfeile in diesen Kanälen bei Fig. 1 angedeutet ist. Außerdem sind die Wände der Expan-

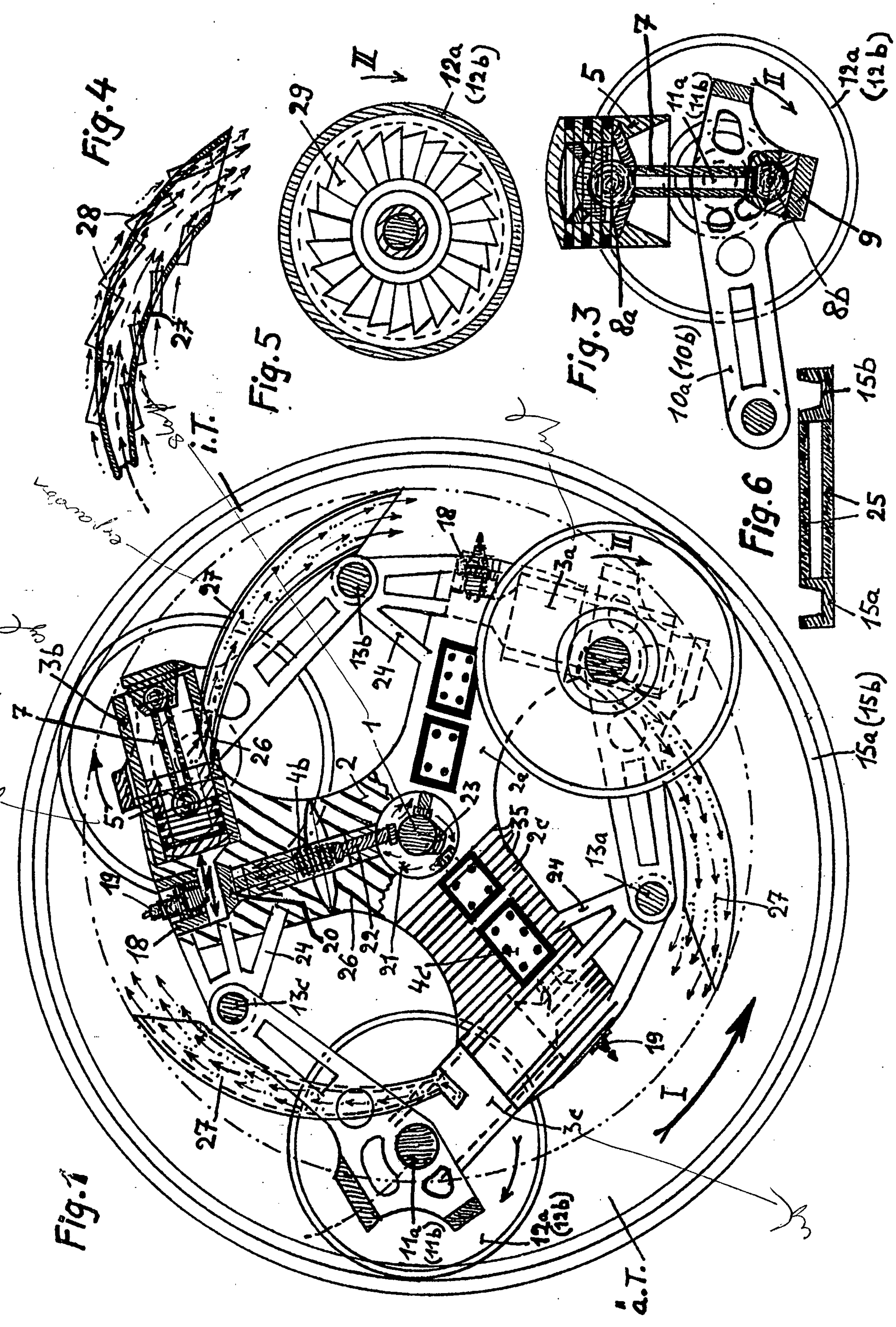
Fig.1
Fig.3
Fig.4
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Fig.6

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TWO-STROKE INTERNAL COMBUSTION ENGINE WITH REVOLVING CYLINDERS
[Zweitakt-Brennkraftmaschine mit umlaufenden Zylindern]

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The present invention relates to a preferably mixed-compression two-stroke internal combustion engine, whose working pistons move back and forth tangential to the generally vertical shaft and simultaneously revolve concentric around the shaft together with their cylinders arranged in a common, approximately star-shaped body. The torque for the revolving movement of the cylinder body and the shaft is generated in that the pistons are supported towards the outside against a stationary bearing race with an eccentricity corresponding to the piston stroke relative to the shaft, namely in the sense of [German] Patent No. 831 034, by means of a running gear with two rollers guided in the two tracks of the bearing race arranged symmetric to the piston axis and a rod assembly, which is linked on one side to the outer end of the connecting rod and on the other end to the following arm of the cylinder body. The running-gear rod assembly consisting of a transverse hoop and two lateral braces carrying the bearing journals for the rollers is constructed so that the connecting rod executes only a relatively small back-and-forth motion in the revolving plane during the piston stroke, wherein also only moderate lateral piston pressures are produced against the cylinder walls and a greater ratio of piston stroke to cylinder diameter is possible than for a typical crank mechanism.

Now, in order to even further increase the power capability of such an internal combustion engine relative to the stroke volume, the relevant construction type according to Patent No. 831 034 is improved by this invention. The essential features in this sense are the arrangement of the cylinders provided for axial scavenging with inlet valves and outlet slots at the farthest possible distance from the shaft at the outer end of each arm of the cylinder body and the connection of the cylinder outlet slots at the outer stroke end of the working piston with expansion channels, which open in the tangential direction and whose side walls are interrupted by pipe connecting pieces running approximately in the direction of flow.

In this connection, even further changes and improvements are provided, which are produced partially from the preferred installation position of the engine, for example, in a motor vehicle, and are partially also of considerable importance for an advantageous operation of this engine or good accessibility of individual components, e.g., the inlet valves, and are explained in more detail below.

The subject matter of the invention is shown in the drawing in agreement with Patent No. 831 034 in the embodiment of a three-cylinder internal combustion engine, wherein the same reference symbols are also used here and there for components corresponding to each other; shown are:

Figure 1, the entire engine in a plane perpendicular to the shaft, partially in perspective, partially in section,

Figure 2, the engine in axial section,

Figure 3, a working piston in longitudinal section with the parts of its running gear lying on one side of this piston,

Figures 4, 5, and 6, each an individual component in longitudinal or cross section, and also

Figure 7, a graphical representation of the lateral amplitude of the connecting rod during the piston stroke.

A three-armed body 2, which can rotate only together with the shaft and which contains a working cylinder 3^a, 3^b, 3^c partially projecting from its respective arm 2^a, 2^b, 2^c at the outer end of this arm, is arranged on the shaft 1. An inlet channel 4^a, 4^b, 4^c connects to the internal end of each cylinder, whose longitudinal axes have the greatest possible distance from the shaft tangents running parallel to these axes. These channels directed radial to the shaft are closed at their outer end by threaded connecting pieces 18, in which spark plugs 19 are arranged. In the other part of the channels there are inlet valves 20, whose tappets 22 reaching into an annular space 21 within the hub borehole of the cylinder body are actuated by means of a common, stationary cam 23.

The working pistons 5 have a connecting rod 7, which is constructed as a pipe and which is connected in an articulated way by a spherical bearing 8^a or 8^b on one side to the piston and on the other side to a support transverse hoop 9 of the running gear. Two identical, angular braces 10^a, 10^b with legs of different lengths are attached to the transverse hoop symmetric to both sides of the piston axis and parallel to each other. These braces carry the bearing journals 11^a, 11^b for each track roller 12^a, 12^b and are hinged at the other end of their longer leg by means of a common journal 13^a or 13^b or 13^c to a projecting bearing block 24 of the arm of the cylinder body 2 following in the revolving direction (cf. the arrow I in Figure 1).

In this way, a much smaller lateral amplitude of the connecting rod is produced than in a crank mechanism for the same piston stroke, because, in contrast to that of a crankshaft, the rotational axis of the track rollers can change its position relative to the piston axis. The outer end of the connecting rod thus moves along a circular arc, as shown in Figure 7, whose radius is the longer leg of the braces 10^a, 10^b, which move back and forth in the range of an angle α about the pivot pin 13^a or 13^b or 13^c. The chord of the circular arc corresponds to the piston stroke H, while the height of the circular arc dependent on the length of the relevant brace leg past the chord represents the entire side movement of the outer connecting-rod end. Consequently, the connecting rod is deflected towards each side from the piston axis characterized by the line K-A by half this arc height. Thus, also only very small radial piston pressures are generated against the cylinder wall, which allows a greater stroke:diameter ratio than for engines with a crank mechanism.

The two track rollers of the individual piston running gears are each guided in a groove 15^a, 15^b with a U-shaped cross section in a fixed, double bearing race eccentrically surrounding the shaft and the cylinder body, whose constant track width is ensured by annular spacers 25 (cf. Figures 2 and 6). If it is desired to be able to change the piston stroke caused by the eccentricity of the bearing race, this can be

achieved through a corresponding (not shown) adjustment device for the bearing race. In Figure 1, the positions at which the working pistons have their bottom and upper dead center position are designated with i.T. and ä.T., respectively.

The guide and influence of the combustion gases emerging from the working cylinders through outlet slots 26 arranged at the outer stroke end of the pistons and controlled by these pistons represents a special feature of the novel construction. To be able to make the most significant possible use of the back pressure created by the exhaust push in the sense of increasing the power of the internal combustion engine for the torque exerted on the cylinder body and thus also on the shaft, all of the outlet slots of each cylinder are connected to a corresponding expansion channel 27, which extends against the rotational direction of the cylinder body and which is curved so that the exhaust gases have in their outlet cross section a tangential flow direction in the relevant sense, as indicated by the small arrows in these channels in Figure 1. In addition, the walls of the expansion channels are interrupted by short pipe connecting pieces 28, which run approximately in the corresponding flow direction of the gases and at whose end within such a channel a vacuum pressure is produced due to the gas flow. In this way, fresh air is suctioned at the relevant positions preferably distributed over the periphery and the length of the channels. This fresh air mixes with the exhaust gases. The consequence is, apart from the reduction in outflow speed caused by the increase in gas volume, wherein this outflow speed is to be adapted in the sense of the highest possible backstroke power through suitable dimensioning of the suctioned air volume of the revolving speed of the cylinder body, a lower temperature of the combustion gases discharged into the surroundings, connected with sound damping, which is produced by the enveloping of the hot exhaust-gas core in a cool air shell and their increasingly mutual mixing. In Figure 1, the expansion channels 27 are shown with the pipe connecting pieces 28 for the purpose of simplified representation.

While the expansion channels for the exhaust gases are already effectively cooled by the previously described measures, for other cooling, especially for the piston running gear, the track rollers produced in the inner part from lightweight metal and on the periphery from a steel ring with a T-shaped cross section have an opening in the region between their hub and their collar and are here provided with mutually overlapping blades 29 at an angle to their plane, so that they act simultaneously as cooling fans for their revolution about their own axis in the arrow direction II (cf. Figure 5).

In order to reliably guide the cylinder body in consideration of its mass lying with a considerable portion at a relatively large distance from the shaft, it is supported on this on both sides of the inlet control cam 23 lying in the center plane of the cylinder. At one bearing point, for a horizontal rotational plane of the body, as assumed in the present case, and a vertical shaft underneath the inlet cam, it directly envelops the shaft; here, the torque is transferred from the cylinder body to the shaft. At the other position, above the inlet cam, a ball bearing 30 is provided, whose inner ring is arranged on a fixed axis 31 running coaxial to the shaft, wherein this axis also carries the inlet cam, while the outer ring of this ball bearing is connected to the hub of the cylinder body and revolves together with this body.

Through the annular space 21 defined on the inside by the axis 31 and on the outside by the hub of the cylinder body 2, the fuel-air mixture is fed to the inlet valves 20, wherein simultaneously the ball bearing 30 and the cam 23 are lubricated or cooled. The suction of the cool air is realized through openings 33 arranged on the top side of the crankcase 32 via filters 34. The cooling effect of the air flowing into the space between the bearing race and the cylinder body parts and applied directly to parts of the working cylinder and spark plugs projecting from the cylinder body onto the other part of the working cylinder is amplified by ribs 35 on the periphery of the individual arms of the cylinder body. Then this air is discharged back into the surroundings through an opening 36 at the bottom side of the crankcase in the direction dependent on a guide plate 37.

The path of the cool air through the interior of the crankcase is illustrated in Figure 2 by small arrows.

The carburetor 38 is also arranged on the top side of the crankcase; the fuel is fed to it via a pipe line 39, optionally after pre-heating and the air necessary for forming the mixture is fed to it through a nozzle 40 via a special filter 41.

The weight of the cylinder body is held by an axial pressure bearing 42, by means of which the body is supported against a gearbox 43, which is connected to the bottom side of the crankcase 32 and which is shown in Figure 2 only in its outline without additional parts. Underneath the gearbox are the parts of the electrical system of the internal combustion engine in a similarly enclosed space 44. Of these parts, only the ignition cam 45 arranged at the lower end of the shaft 1 reaching into this space can be seen from Figure 2. This cam, as can be easily understood, is formed according to the number of cylinders as a trident cam with mutually isolated poles, of which each is connected to the associated spark plug by a cable. Additional details concerning the timely actuation of the spark plugs are left out, because they are generally known from other mixed-compression internal combustion engines with external ignition. The battery 46 is inserted into a recess of the crankcase so that it is easily accessible from above.

The construction even further improved with this invention for such an internal combustion engine is suitable primarily for purposes in which what matters is high power in ratio to spatial requirements and weight, e.g., for motor vehicles. That all of the components under consideration of their operating requirements will be constructed as lightweight as possible through extensive use of lightweight metal shall be mentioned only in passing. Also important are good cooling and lubrication, which increase operating reliability. The inlet valves are easily accessible due to the arrangement of removable covers 41 on the arms of the cylinder body and can be inserted from this side after removal of the spark plugs 19 and the screw closures 18. Also, due to their radial position, relatively large valve opening cross

sections are provided, which guarantee especially thorough scavenging together with the axial flow through the working cylinders from the inlet to the outlet. Finally, due to the presence of the inlet valves, a simpler shape is given for the working pistons than when these pistons themselves control the inlet channel and would therefore have to have a correspondingly shaped base or even a cylindrical projection of smaller diameter (control piston).

Claims

1. Two-stroke internal combustion engine with revolving working cylinders, which are arranged tangential to the shaft in a body connected rigidly to this shaft and whose working pistons are supported on the outside against a stationary bearing race according to Patent No. 831 034 eccentric to the shaft and to the cylinder body by means of two rollers of a running gear, whose rod assembly is constructed and connected in an articulating way on one side to the outer end of the connecting rod and on the other side to the cylinder body, such that the connecting rod executes a relatively small back and forth movement during the piston stroke in the rotational plane of the cylinder body, characterized in that the cylinders (3^a, 3^b, 3^c) are located at the greatest possible distance from the shaft (1) at the outer end of each arm (2^a or 2^b or 2^c) of the cylinder body (2) and have inlet valves (18), which are accommodated in radial boreholes (4^a, 4^b, 4^c) of the cylinder body arms and are actuated in a known way for controlling the mixture feeding at the inner cylinder end by a common, stationary cam (23), while the discharge of the exhaust gases is realized in tangential directions against the rotational direction of the cylinder body via outlet slots (26) provided on the outer stroke end of the working piston (5) and controlled by this piston.

2. Internal combustion engine according to Claim 1, characterized in that the cylinder outlet slots (26) are connected to expansion channels (27), in which the speed of the exhaust gases of each cylinder is converted in the sense of a diffuser effect increasing in pressure.

3. Internal combustion engine according to Claim 2, characterized in that the side walls of the expansion channels are interrupted by short pipe connecting pieces (28) running in the corresponding flow direction of the exhaust gases, wherein, through these connecting pieces, air is suctioned from the outside due to the effect of vacuum pressure and added to the exhaust gases.

4. Internal combustion engine according to Claim 1, characterized in that the cylinder body (2) is supported on both sides of the control cam (23) arranged in the longitudinal center plane of the cylinder for the inlet valves (20), namely, on one side, for a horizontal revolving plane underneath the cam, on the shaft (1) and, on the other side, on a stationary axis (31), which is arranged coaxial to this shaft and on which the inlet cam is also located.

5. Internal combustion engine according to Claim 4, characterized in that a radial bearing, for example, a ball bearing (30), is arranged between the cylinder body (2) and the axis (31) with a stationary inner ring and a revolving outer ring in an annular space (21), which is used for feeding the fuel-air mixture to the inlet valves (20).

6. Internal combustion engine according to Claims 4 and 5, characterized in that the cylinder body (2) is supported, for a horizontal revolving plane, at the bottom by means of an axial pressure bearing (42) against the crankcase (32) or a component, for example, the gearbox (43), connected rigidly to this crankcase.

7. Internal combustion engine according to Claim 1, characterized in that the radial boreholes (4^a, 4^b, 4^c) of the arms of the cylinder body, in which the inlet valves (20) are accommodated, are closed on

their outer end by threaded connecting pieces (18), in which spark plugs (19) actuated by a common cam (45) arranged on the shaft (1) and constructed according to the number of cylinders, are located.

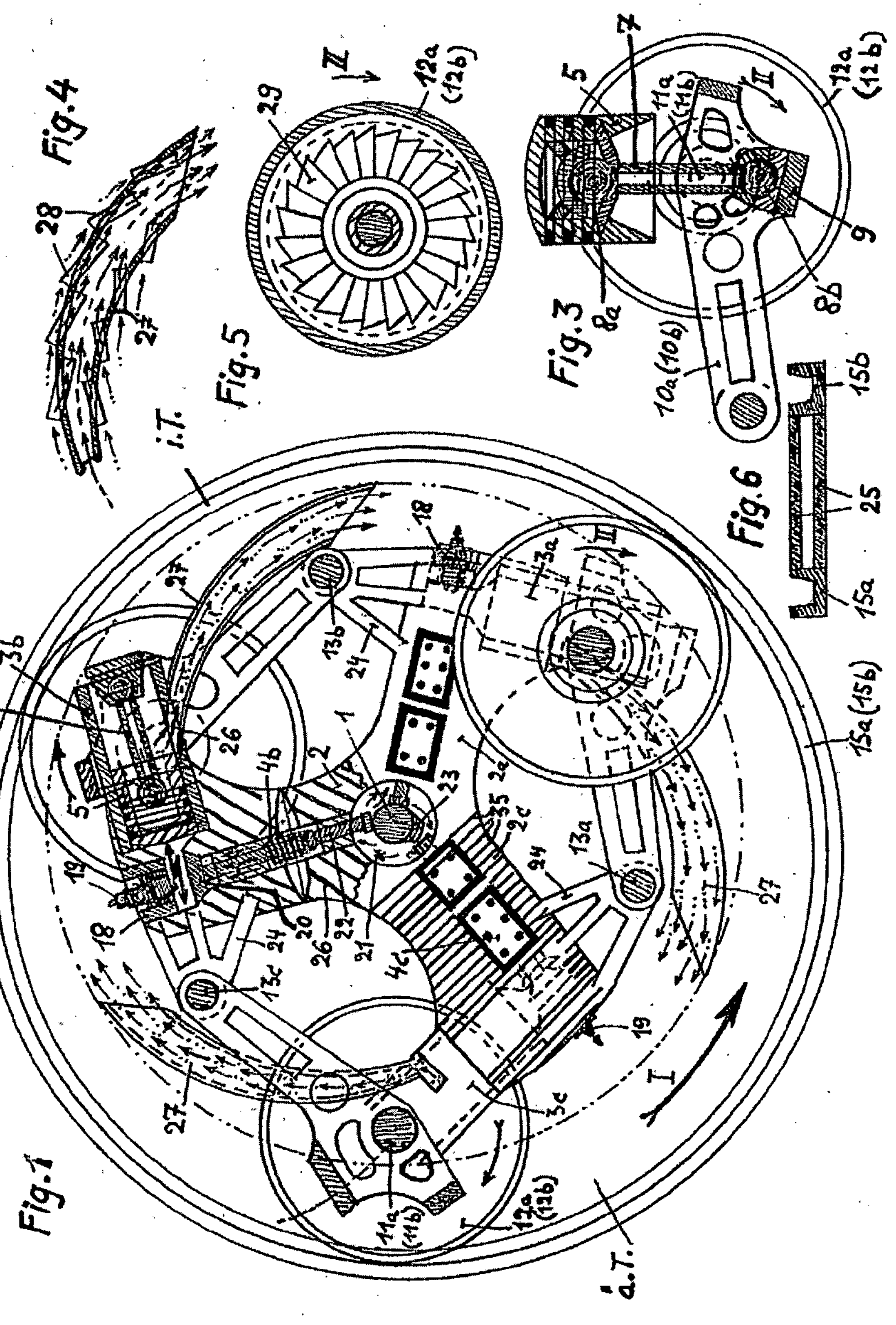
Fig.1
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Fig.6

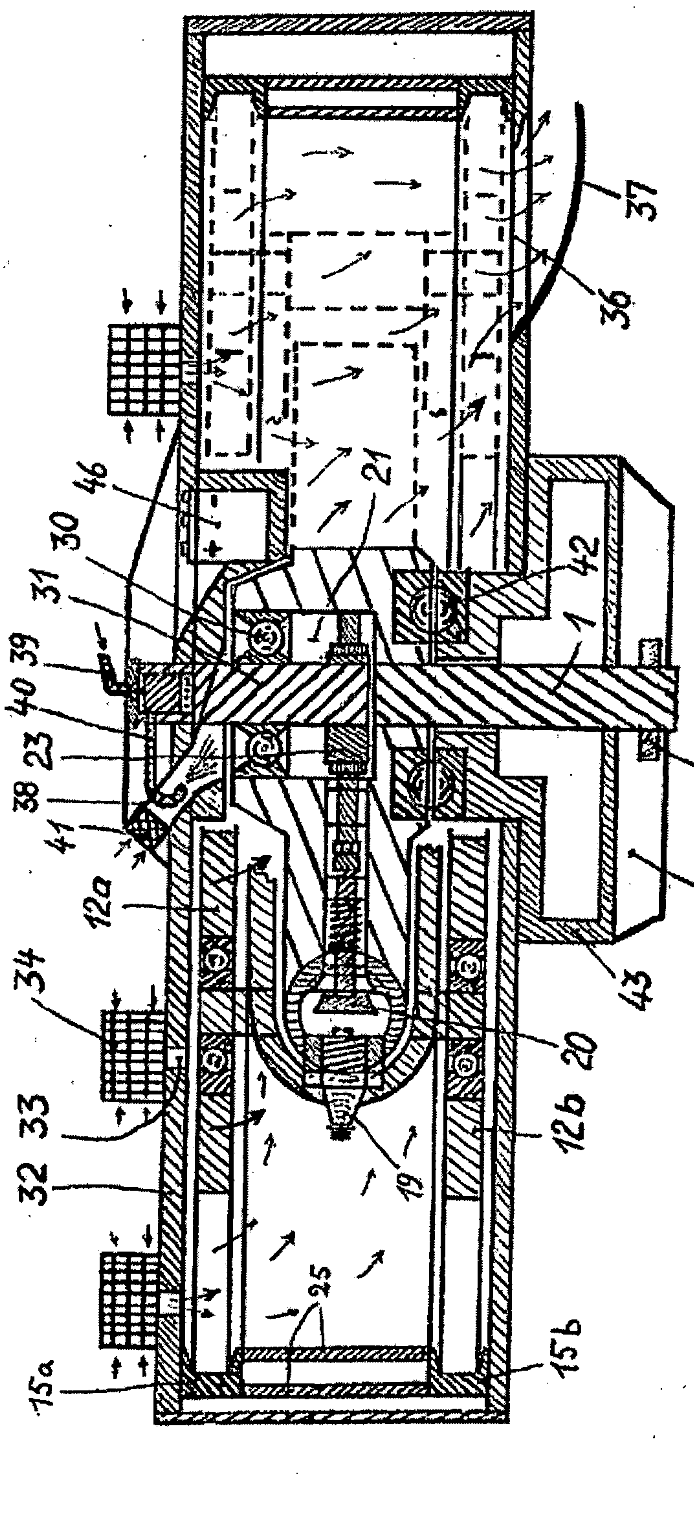
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Fig. 2

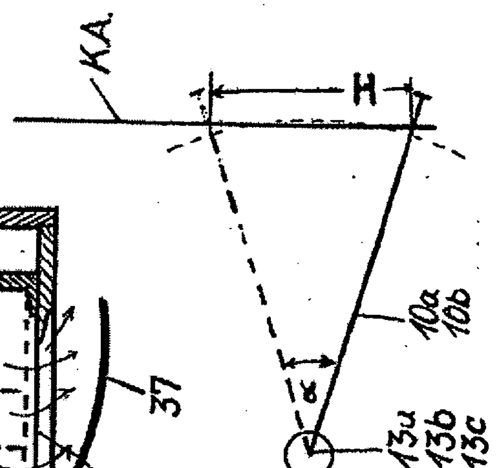
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Fig. 7